

# Shipborne Scatterometer Measurements of Great Lakes Ice

*S. V. NGHIEM<sup>1</sup>, G. A. LESHKEVICH<sup>2</sup>, and R. KWOK<sup>1</sup>*

<sup>1</sup>*Jet Propulsion Laboratory, California Institute of Technology, MS 300-235  
4800 Oak Grove Drive, Pasadena, California 91109, U. S. A.  
Tel: 818-354-2982, Fax: 818-393-3077, E-mail: nghiem@solar.jpl.nasa.gov*

<sup>2</sup>*Great Lakes Environmental Research Laboratory  
National Oceanic and Atmospheric Administration  
2205 Commonwealth Blvd., Ann Arbor, Michigan, U. S. A.  
Tel: 734-741-2265, Fax: 734-741-2055, E-mail: leshkevich@glrl.noaa.gov*

The Jet Propulsion Laboratory C-band polarimetric scatterometer was used to measure radar backscatter of Great Lakes ice. The scatterometer data are at the same frequency band, incident angles, and polarizations of operating satellite SARs such as RADARSAT and ERS or future multipolarization SARs such as ENVISAT. An experimental campaign was carried out across the Straits of Mackinac and over Lake Superior in the 1997 winter season with the JPL scatterometer integrated on U.S. Coast Guard Ice Breaker vessels. During the experiments, in situ data for different ice types were obtained and accurate radar calibration measurements were conducted. We acquired backscatter signatures of various ice types with different physical conditions, feature scale, thickness, snow cover, and concentration. Measured backscatter data of typical snow covered lake ice indicate that the horizontal backscatter is larger than the vertical backscatter especially at larger incident angles. This backscatter property of lake ice is different from that of most sea ice types whose vertical return is usually larger than the horizontal one. Scatterometer data of the typical lake ice type taken in March along the ship track show that C-band waves can propagate through the ice layer. For deformed ice in a rubble field, the backscatter is very strong across the range of incident angles (20-60 degrees). Backscatter of pancake ice has a steep slope as a function of incident angle and the complex copolarized polarimetric correlation coefficient has a small magnitude at large incident angles. Black ice with a thin snow cover has low backscatter with a strong decreasing gradient in incident angle. The scatterometer data set is useful for the development of the Great Lakes ice mapping algorithm.